FINAL TECHNICAL REPORT

Monitoring Situational Awareness in Tactical Information Displays with Eye-Tracking Instrumentation

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Project Number:	N00014-95-1-1091
Project Title:	Monitoring Situational Awareness in Tactical Information Displays with Eye-Tracking Instrumentation
Principal Investigator:	Sandra P. Marshall
Institution:	San Diego State University
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Equipment Purchases:

Vendor/Manufacturer	Equipment	Amount
Folsom Research	Video Scan Converter	$10,132
Gateway 2000	Pentium Computer	4,182
Applied Science Laboratory	4000CU Eyetracking System	60,023
Systems Resource Group	Pentium Computer for EMG	4,697
Audio & Visual Supply	TV & VCR (for data display)	1,084
Cousins	TV & VCR (for data analysis)	1,094
Mega Electronics	MikroMak 3D Video EMG	10,000
Mega Electronics	High Speed Analysis System (EMG data)	15,289

Modification of purchases as described in original proposal:

The original proposal was based on a price quotation from Applied Science Laboratory in which ASL agreed to supply both its basic system and the necessary accompanying hardware such as the Pentium computer and monitor. ASL had also included a quote for acquiring and installing the EMG equipment from Mega Electronics. After additional and extended consultation with ASL, we elected to purchase these accompanying items directly from their manufacturers instead of working through ASL because we were able to negotiate educational discounts that ASL could not provide on products they obtained from other manufacturers.

The significant modification we have made to the original proposal was the decision to use a scan converter to transmit the signal from the target computer screen observed by the experimental subject to the eyetracking system. This option was not known to us when we developed the original proposal, but we determined after consultation with ASL personnel that the scan converter option would allow us to collect data and conduct analyses more efficiently without additional cost. Under this configuration, we substituted the scan converter for the stationary scene camera configuration that was originally budgeted.

Use of the equipment:

(1) Startup and Training

Several months were required to acquire and set up the equipment. As proposed, one technician from Applied Science Laboratory came to San Diego for initial installation and training with the eye tracking system.

As expected, additional time was needed to train SDSU personnel to use the system reliably for experimental purposes. Included in their training was experience in calibrating the eye-head signals with the target video display, practice in adjusting quickly and accurately the head camera for a variety of different situations, and the development of expertise in managing the software that directs the eye tracking system. Altogether, the first six months were allocated to acquisition and training.

(2) Use of the equipment in existing research projects

Currently, we have completed two research studies in which we collected more than 60 hours of eye-tracking data (approximately 3 hours each for 20 subjects). This research is in conjunction with the ONR-funded project entitled, "Learning in Tactical Decision-Making Situations: A Hybrid Model of Schema Development and Use" (N00014-95-1-0237). As part of these studies, we have investigated the eye movements of subjects as they engaged in a series of complex computer tasks. Among the variables of interest were fixation duration, areas of extended dwell time, and pupil dilation. We are currently relating the eye-tracking results to the cognitive modeling of subject performance on the tasks, which is a central objective of the hybrid architecture project.

Several interesting findings have emerged from our studies. We have observed large differences among subjects on all variables of interest. In particular, our subjects do not necessarily allocate their visual attention in similar ways. The implication for our cognitive models is that we need to begin the modeling process with some estimate of each individual's gaze behavior. We have also observed some relatively strong patterns in the data over most of our subjects. Although our findings are still preliminary, we have found substantial confirmation that pupil dilation in general reflects important aspects of cognitive complexity of the task performed by the subject. We continue to pursue this research.

One additional and unexpected finding emerged from our analysis of subjects' eye movement behavior as they learned to use the system. With this equipment, we were able to determine precisely whether subjects gave explicit visual attention to the various parts of instruction and the order in which they did so. This information greatly enhances our models of learning and performance because it informs us of areas that a subject was likely to have learned (by gazing at them) as well as those which could not possibly be known (because the subject never looked at them). It also has potential importance for other training situations. We are exploring this implication in our current work.

Acquisition of the EMG equipment has taken longer than we initially expected, and we have not yet completed an experiment using it. However, we have successfully carried out pilot studies in which the EMG equipment was interfaced with the eye-tracking system. As part of our investigation, we have studied the optimal placement of the electrodes for best recording of data, and the coordination of the two systems is complete. We are also beginning to study how to capture eye blink information with these systems. We anticipate several new studies in which we examine several of these physiological measures and their relationship to cognitive performance measures.

Plans are under way for temporarily moving the equipment to the Navy research facility at NRaD. In the original proposal, we expected to use the equipment as part of the TADMUS project and the ONR research grant entitled, "Decision-Making Schemas in Rapidly Changing and Ambiguous Situation" (N00014-93-1-0525) in which decision making of Navy officers is being studied. We have been delayed in our efforts to implement eye tracking in the TADMUS project because the San Diego team of TADMUS personnel have been physically relocated. Their new laboratory is now operative, and we are once again working with the TADMUS research group. Initial trial runs are planned before the end of August 1996. We anticipate that we will be able to gather usable data with them in the next few months.

(3) Proposed use of the equipment in future DOD projects

We are intending to use this equipment as an integral part of a larger MURI project proposed as a collaboration between researchers at San Diego State University and George Mason University. We are proposing to study cognitive workload, and we anticipate that our eye-tracking and EMG systems will allow us to develop new measures of workload that will have practical and theoretical applications. Many of the measures we have already investigated will be pertinent to this effort.

Training of future scientists with this equipment

A large number of graduate and undergraduate students are being trained to use the equipment purchased under this award. Currently, five graduate students and one undergraduate are working with the eye tracking system. Four undergraduate students are learning to use the EMG equipment. The graduate students are all studying psychology. The undergraduates are biology and physics majors. Among the ten students working with this equipment are five women, two Hispanic students, one Chinese student, and one Filipino student.